STUDY OF A LEACHING Cu(II) FROM SULFIDE CONCENTRATE BY COMBINED METHOD

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ICASE 2021

Abstract

This study was undertaken to develop a cost-effective method of copper leaching in sulfide concentrate involving minerals as chalcopyrite and pyrite. The combined methods involving low temperature roasting of sulfide copper minerals with potassium chlorides without the formation of sulfurous gases and their evolution into the atmosphere are suggested. The effect of experimental parameters such as a roasting temperature and time has been presented and discussed in detail. This study was carried out in the roasting temperature range 400-600°C and roasting time ranges 1-4 h with potassium chloride. The obtained cake is leached by an aqueous sulfuric acid 60 g/l concentrated at pH=2-2.5 and 4 h. The recovery of copper into the solution at optimal roasting condition (500°C, roasting time 3 h) is 93.2%.

Introduction

The pyrometallurgical process is widely used to extract copper from chalcopyrite; however, with increasing worldwide copper production, copper ores are becoming increasingly scarce, and more sulfur dioxide (SO_2) is being released into the atmosphere [1]. The combined methods involving low temperature roasting of sulfide copper minerals with potassium chlorides without the formation of sulfurous gases and their evolution into the atmosphere are suggested. Copper concentrates contain sulfide minerals such as chalcopyrite, pyrite, chalcocite, covelline, and bornite. Therefore, the list of possible reactions accompanying their chlorinating roasting can be continued [4,5].

Chlorinating roasting of copper sulfide minerals under an atmosphere for removing metals has continued to remain a subject of interest. Bayer and Weidemann have observed that the salt roasting is spontaneous for KCl, slower for NH_4Cl, and variable rate for NaCl. They have studied on salt roasting of chalcopyrite at low temperatures (473-513 K) by thermo analytical technique [6]. The chemistry of the salt-roasting process is very complex because several processes, such as oxidation, sulphation, in situ chlorination, and evaporation of volatile species, occur either simultaneously or sequentially [7]. The non-isothermal analysis confirmed the chemical control mechanism at temperatures below 620K [8].

Methods And Materials

Sulfide copper concentrate originating from copper mine, Mongolia, with 28,68% of Cu, 34.52% of Fe, 32.2% of S, 4.6% other elements were used in the investigation. The sample contains 21.49 g/ton of Au, 47.69 g/ton of Ag. The copper concentrate included chalcopyrite ($CuFeS_2$) 59.56%, pyrite (FeS_2) 14.23%, hematite (Fe_2O_3) 2.1% and albite ($Na[AlSi_3O_8]$) 5.95%, anorthite ($CaAl_2Si_2O_8$) 11.68%, quartz (SiO_2) 6.45% were identified by XRD. The SEM-EDX of concentrate is shown in Fig. 2. The elemental composition of concentrate determined Fe 34.89%, Cu 27.41%, and S 6.11% from EDX analysis.

Methods:

- Weight ratio of concentrate and KCl 1:0.7
- Roasting temperature range: 400-600°C
- Roasting time: 1,2,3, and 4 h
- Leaching time: 1,2,3, and 4 h
- Sulfuric acid concentrate: 60g/l
- Solid and liquid ration 1:9

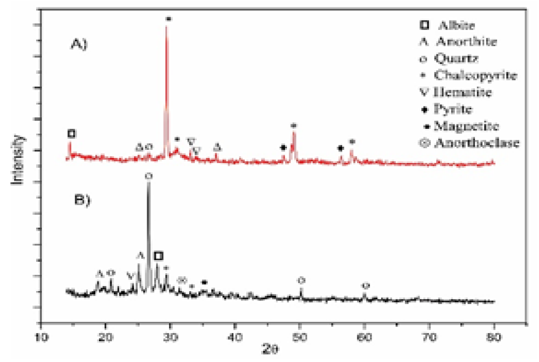

Figure 1. XRD pattern of copper concentrate A) and copper ore B)

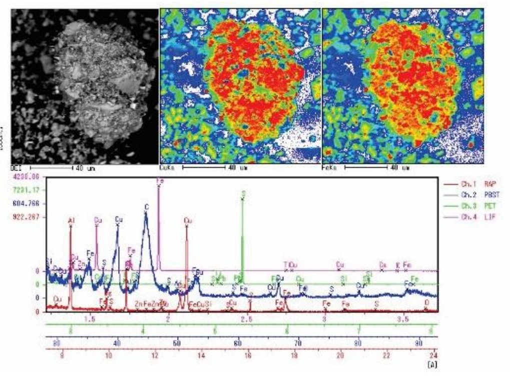

Figure 2. SEM-EDX of copper concentrate.

Results

Effect of copper concentrate and KCl weight ratio

It was observed that a ratio had no significant effect on the removing copper when maintained at 1/0.7 or higher. Based on these results, a concentrate/KCl weight ratio at 1/7 was chosen for all subsequent experiments.

Effect of Roasting Temperature and Time

At 400°C, the recovery of copper was 66.3%, observed as not high when leaching time was 2 hours. At this temperature, the chemical reaction did not succeed. It may relate that not possessing enough energy was in the system what is required. At 600°C, the recovery of copper became almost constant when the range of time was 1-3 hours. After 3 hours, the recovery of copper was increased (54.3%), but not enough. The recovery of copper into the solution at optimum condition (roasting temperature 500°C, roasting time 3 h, concentrate and potassium chloride 1:0.7) was 93.2%. From Fig. 4, it can be seen that roasting cake surface was changed, and the copper sulfide minerals oxidized with KCl, it consists of (wt %) 30.83 Cu, 11.03 Fe, 24.84 K, 11.73 S, 10.07 O and 7.98 Cl from the SEM-EDX analysis. The XRD results are shown that the roasting process of copper sulfide minerals was oxidized with KCl and the oxidized products of copper were leached in sulfuric acidic solution completely.

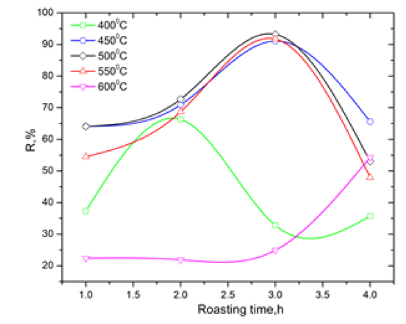

Figure 4. Effect of roasting temperature and time on recovery copper .

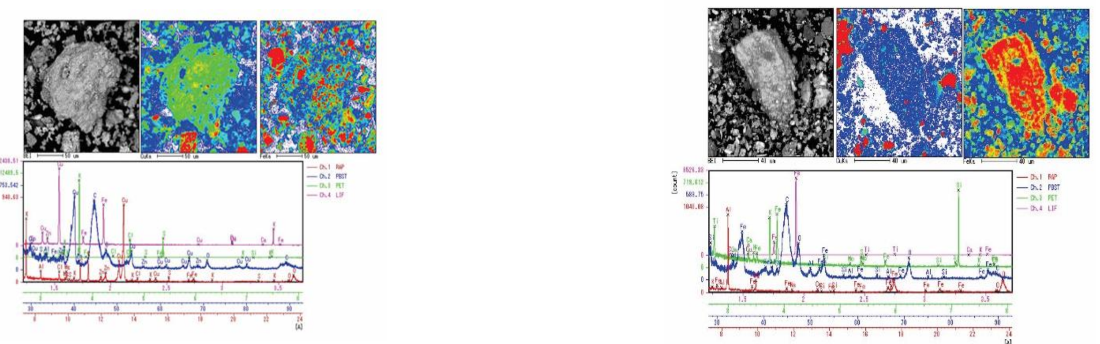

Figure 4. SEM-EDX of copper concentrate after roasting A), and solid residue after leaching (B).

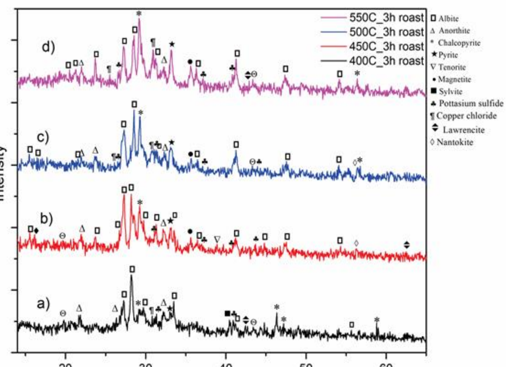

Figure 5. XRD pattern of copper concentrate after roasting at temperature between 400-550°C
a)400°C,3h roasted b) 450°C,3h roasted
c) 500°C,3h roasted d) 550°C,3h roasted

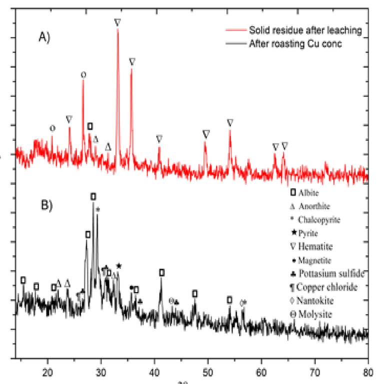

Figure 6. XRD pattern of solid phase after leaching A) and copper concentrate after roasting at 500°C

Discussion

The effect of experimental parameters such as the concentrate/KCl weight ratio, roasting temperature and time have been studied and discussed in detail.The ratio of concentrate/ KCl is often an important parameter for the roasting and leaching process. In order to examine the influence of removing copper on the changing of concentrate/KCl weight ratio, the copper concentrate was roasted at 450°C, 500°C, 550°C, and 600°C. The concentrate/KCl weight ratio was held at 1/0.6, 1/0.7, 1/0.8, and 1/0.9. Experiments of roasting with KCl were performed according to the flowchart presented in Fig. 3 at different roasting temperatures (400-600°C) and roasting time (1-4 h). The roasted cake was leached at the condition above mentioned.

Conclusions

Thus, we can conclude the following results according to the development of processing the sulfide copper concentrate:

1. This study demonstrated the possibility of the combined process for copper recovery in laboratory conditions.
2. The recovery of copper into the solution at the feasible condition of roasting temperature 500°C, roasting time 3 h, concentrate/potassium chloride weight ratio 1/0.7, leaching time 4 h, leaching temperature of 25°C is 93.2%.
3. A high iron and low sulfur contents in solid residue allow us to obtain high-quality copper from the leaching solution. The combined method involving low-temperature roasting of sulfide copper minerals with potassium chlorides without the formation of sulfurous gases and their evolution into the atmosphere is suggested.

Future Directions

In future work, investigating of the effect Fe(III) leaching process might prove important.
It will be important that future research investigate to possibility reusing potassium chloride for this roasting process.

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